Machida Hiroaki

# HW#6 - METCS 248

**1.** Simplify the following expression: $(p'.q)+(p.q)+(p.q')$

$(p'\cdot q)+(p\cdot q)+(p\cdot q') = (p'\cdot q)+p(q+q')$

$= (p'\cdot q)+p = (p+p')(p+q)$

$= p+q$

**2.** Find the sum-of-products of $f(x,y,z)$.

| $X$ | $y$ | $z$ | $f(x, y, z)$ |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 |

$x'y'z' + x'yz + xy'z' + xyz'$

**3.** Write the expression $(x.y)'.z$ in terms of each of the following:

a) + and ' (disjunction, and negation.)

$(x\cdot y)'\cdot z = (x'+y')\cdot z$

$= ((x'+y')\cdot z)'' = ((x'+y')'+z')'$

b) NAND operator.

$(x\cdot y)'\cdot z = (((x\cdot y)'\cdot z)')' = (((x\cdot y)'\cdot z')\cdot((x\cdot y)'\cdot z'))'$

$((x \text{ NAND } y) \text{ NAND } z) \text{ NAND } ((x \text{ NAND } y) \text{ NAND } z)$

**4.** Draw the Karnaugh map for $f(x,y,z)$ in problem 2 and **minimize** the function.

| | $xy$ | $xy'$ | $x'y'$ | $x'y$ |
|---|---|---|---|---|
| $z$ | | | | 1 |
| $z'$ | 1 | 1 | 1 | |

$xz' + x'y'z' + x'yz$

**5.** Draw the Karnaugh map for $g(x,y,z,w)$, where $g(x,y,z,w)$ is "1" for the following x, y, z, w:

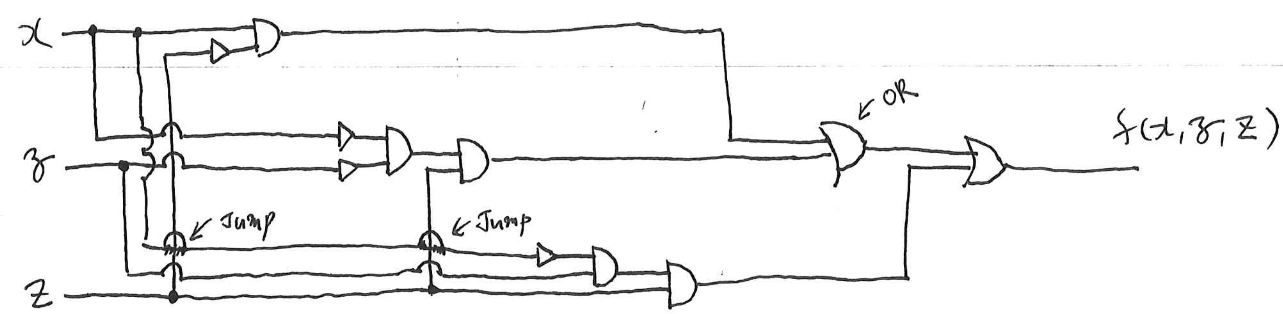
| | $xy$ | $xy'$ | $x'y'$ | $x'y$ |
|---|---|---|---|---|
| $zw$ | | 1 | 1 | |
| $zw'$ | 1 | | 1 | 1 |
| $z'w'$ | 1 | | | |
| $z'w$ | | 1 | | 1 |

$xyw' + y'zw + xy'w + x'zw' + x'yz'w$

0010, 0011, 0101, 0110, 1001, 1011, 1100, 1110, and $g(x,y,z,w) = 0$ elsewhere. Minimize the function.

**6.** Draw the logic circuit for the expression in problem *4* using only 2 input gates.

$x \cdot z' + x' \cdot y' \cdot z + x' \cdot y \cdot z$




**7.** Show that NOR is complete set of operators.

You can make OR, AND and NOT, that is a complete set of operators, from NOR.

OR: (X NOR Y) NOR (X NOR Y)

| x | y | |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

AND: (X NOR X) NOR (Y NOR Y)

| x | y | |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

NOT: X NOR X

| x | |
|---|---|
| 0 | 1 |
| 1 | 0 |

**8)** Write the following expression as a sum of minterms: $f(x, y, z) = xyz' + x'z + y$, then simplify.

| x | y | z | f(x,y,z) | |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | |
| 0 | 0 | 1 | 1 | – $x'y'z$ |
| 0 | 1 | 0 | 1 | – $x'yz'$ |
| 0 | 1 | 1 | 1 | – $x'yz$ |
| 1 | 0 | 0 | 0 | |
| 1 | 0 | 1 | 0 | |
| 1 | 1 | 0 | 1 | – $xyz'$ |
| 1 | 1 | 1 | 1 | – $xyz$ |

$x'y'z + x'yz' + x'yz + xyz' + xyz$

| | $xy$ | $xy'$ | $x'y'$ | $x'y$ |
|---|---|---|---|---|
| $z$ | 1 | | 1 | 1 |
| $z'$ | 1 | | | 1 |

$y + x'z$